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Social Inhibition in Population-Based and Cardiac Patient Samples:
Robustness of Inhibition, Sensitivity and Withdrawal as Distinct Facets

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Abstract

Objective: Behavioral inhibition plays a key role in animal stress research and developmental research in children. Therefore, we examined the robustness of our multifaceted model of adult social inhibition that comprises *behavioral inhibition*, *interpersonal sensitivity*, and *social withdrawal* components.

Method: A total of 899 adults completed the 15-item Social Inhibition Questionnaire (SIQ15) and measures of emotional distress. Confirmatory Factor Analysis (CFA), reliability estimates, and correlational and second-order factor analyses were used to examine the robustness of our model.

Results: CFA (RMSEA=.052; NFI=0.938; CFI=0.957) and Cronbach's α estimates $\geq .87$ confirmed the robustness of our multi-facet social inhibition model based on three correlated *inhibition*, *sensitivity*, and *withdrawal* factors in 560 adults from the general population and in 194 undergraduate students. Inhibition, sensitivity, and withdrawal were stable over time (3-month test-retest correlations $\geq .78$), and were closely related to the Gest Behavioral Inhibition and PID-5 Withdrawal measures in a clinical sample of 145 cardiac patients. Of note, male cardiac patients reported more inhibition and withdrawal than female patients. Across samples, social inhibition was distinctly different from negative affectivity.

Conclusions: Our 3-facet model of inhibition, sensitivity and withdrawal was robust across samples, and may promote research on adult social inhibition in population-based and clinical studies.

Key words: social inhibition; SIQ15; personality; mental health; social stress

1. Introduction

People differ in their vulnerability to social stress [1] and other chronic disturbances in terms of life stress [2]. Individual differences in behavior and environmental stressors are also implicated in social stress among nonhuman primates [3]. Hence, in addition to environmental factors, stable attributes of the individual have much explanatory power regarding perceived social threat [2]. Some individuals have ongoing concerns about other peoples' evaluations of themselves [4], or have a preference for social withdrawal in response to social stress [5]. These individual differences in social threat, interpersonal sensitivity and withdrawal have been related to an inhibited temperament [6].

The frequent recurrence of negative interpersonal experiences in everyday life can induce adverse cardiovascular stress responses [7], and increased vulnerability to social threats is characterized by a myriad of cardiovascular stress responses involving heart rate, ventricular contractility, cardiac output, and total peripheral resistance [8-10]. Accordingly, researchers qualify dysfunctional relationships, such as recurrent social stress or lacking social connection, as a risk factor for cardiovascular disease and premature mortality [7, 11-13]. However, inhibited behavior is a complex phenomenon, and it is still unknown which facets of inhibition are related to cardiovascular health [14]. Therefore, we will first briefly discuss distinct facets of inhibition as described in animal and developmental studies. Subsequently, we will examine the robustness of these inhibition facets in human adults, and their clinical relevance in cardiac patients.

1.1. Animal and Developmental Research on Inhibition

Interest in the biological and psychological correlates of this inhibited temperament is motivated by insights from observational research in animals and young children [15]. In animal stress models [16, 17] and developmental studies in children [18, 19], the term behavioral inhibition focuses on the animal's or young child's initial behavioral reactions of fearfulness, wariness, and low approach to unfamiliar situations or persons. A classic way to assess behavioral inhibition is the direct

laboratory observation of animals or young children in standard situations [20]. Individual differences in behavioral inhibition to novelty among monkeys can be assessed using quantified observations of behavior by independent raters [3]. In juvenile monkeys, the degree of freezing behavior reflects individual differences in threat-induced inhibition that are stable over time [21]. Additionally, in rats, low activity in open field and withdrawal from novel situations are indicators of behavioral inhibition [22-24]. In developmental studies of young children, behavioral inhibition is assessed through observation of children's behavior in the laboratory [19] or in naturalistic settings [25], and by parent reports of child behavior [26].

Animal research suggests that stable individual differences in inhibited behavior have a major influence on social stress. A monkey model of social stress showed that inhibited animals had higher rates of violent injuries under conditions of crowding stress, compared with less inhibited animals [3]. In nonhuman primates, inhibited behavioral responses to threat reflect important temperamental differences [21]. This potential role of inhibition in animal models is evident across species. Inhibited rats who display withdrawal for novel social and non-social stimuli [24, 27] are considered a useful animal model to study anxiety vulnerability [23, 28], and research shows that these inhibited rats show an enhanced reactivity to stress [29]. In addition, behavioral inhibition in rats occurs as a response to repeated social defeat [30], and may cause early death due to greater physiological stress responses [16]. These exaggerated stress responses, as indicated by increased cortisol release in the hypothalamic-pituitary axis found in inhibited rats [31], is similar to findings from children with an inhibited temperament [32]. The inhibited response to novel environments among juvenile animals is therefore a behavioral disposition that mirrors inhibition to strangers in young children [17].

Behavioral inhibition affects the development of social cognition and personality in children, making them more susceptible to the adverse effects of social stress [33, 34]. Inhibited children are much less talkative than non-inhibited children, and this phenomenon is a very sensitive sign of

behavioral inhibition after 4 years of age [19]. Several studies confirmed that decreased frequency of speech and increased latency of initiating a conversation are indicative of childhood inhibition [26, 35, 36]. Inhibited children evaluate their interactions with others in terms of self-relevant characteristics, and inhibition in these interactions reflects inhibition towards strangers, (*“Is this person familiar to me?”*) and fear of negative evaluations (*“How will this person react to me?”*), respectively [37].

Developmental research distinguishes inhibition towards unfamiliar people (social inhibition) from inhibition towards unfamiliar objects and contexts (non-social inhibition) [38]. Research in young children showed that there is no correlation between social and non-social inhibition, and that these inhibition types have different temperamental and psychopathological correlates [38-40]. Hence, social and non-social inhibition are two independent constructs that need to be evaluated separately.

1.2. The Many Faces of Social Inhibition in Adulthood

Arguably, these different inhibition processes in childhood also shape the continuity of social inhibition during adolescence and adulthood. While the role of behavioral inhibition in animal stress models is well documented and social inhibition has been widely studied in children, little is known about social inhibition in adults. However, social inhibition, as part of the Type D personality construct, has been associated with the incidence and prognosis of cardiovascular disease [41, 42]. It is therefore essential to gain insight in how social inhibition contributes to the increased risk of cardiovascular disease.

Recently, we defined adult social inhibition as *“a broad and stable personality trait that is characterized by behavioral inhibition during social interaction, increased social-evaluative concerns, and withdrawal from intense social engagement situations”* [43]. A first blueprint of our multi-faceted social inhibition model was presented previously in a review paper on social inhibition and interpersonal sensitivity [15]. Recently, we proposed a more elaborated conceptual model of the

related *behavioral, cognitive* and *affective* facets of social inhibition [43]. We argued that social inhibition in adolescence and adulthood is a broad personality trait that transcends inhibited temperament and behavioral inhibition to the unfamiliar in young children to include different facets that are related to (a) *decreased conversational behavior* and (b) *increased interpersonal sensitivity* during social interaction, and, eventually, (c) a tendency towards social and emotional *withdrawal*.

1.2.1. Biological Underpinning: Inhibited Temperament.

As a starting point, our multi-facet model posits that the initial source of individual differences in social inhibition reflects a stable temperamental disposition [25, 44]. Inhibited temperament is one of the most basic, innate individual differences that can be observed across species [6]. Infants with this early-appearing inhibited temperament are characterized by strong reactions to novelty, such as crying. These infants have a genetically influenced, biological underpinning in temperament, and are predisposed to become behaviorally inhibited with unfamiliar people or situations in the second year of life [19, 44-46]. We will argue that on the basis of this inhibited temperament, social inhibition may further develop across the lifespan, and may manifest itself in prototypical behavioral, cognitive, and affective characteristics that can be observed in middle childhood, adolescence and adulthood.

1.2.2. Behavioral Characteristics: Inhibition in Social Interaction.

Children and adults express their inhibition toward unfamiliar people by a similar pattern of decreased conversational behaviors [35]. In childhood, a decreased amount of time speaking and an increased latency to first spontaneous utterance are powerful behavioral indicators of social inhibition [19, 35]. Socially inhibited children take longer to initiate contact with others, speak less often and for shorter periods of time, and use fewer words as compared to non-inhibited children [26, 47]. In adulthood, people are frequently exposed to situations where they are expected to make contact with others and initiate some conversation topics [48]. However, socially inhibited individuals may have a

hard time making contact with others. They are less talkative [35], and inhibit themselves from providing input on ideas [48]. On a behavioral level, inhibited adults tend to decrease their body movements and vocalization during social interaction [49] and show signs of hesitation in speech [48].

1.2.3. Cognitive Characteristics: Sensitivity to Social Evaluation.

In addition to behavioral inhibition, an inhibited temperament also affects the development of social cognition [50]. Inhibited children become particularly concerned about being criticized, rejected, or ignored by their peers [37]. Whereas many specific childhood fears, such as fear of the dark, decline with age, these social-evaluative concerns typically increase as children get older [38]. Inhibited children may develop a sense of failure when they are rejected or neglected by peers, which, in turn, further increases their level of social inhibition [51]. If early childhood relationships are not satisfactory, they promote inhibited responses to new social situations [51], and predict the onset of internalizing problems [52]. In adulthood, social interactions carry the prospect of interpersonal evaluation where people make judgments of one another [53]. Socially inhibited individuals are particularly concerned with others' evaluations of themselves [1]. They want to gain the approval of others but, at the same time, also fear negative reactions [54]. This fear involves apprehension about others' evaluations and the expectation that others would evaluate oneself negatively [1]. Inhibited individuals develop more sensitivity to criticism from others [48], and interpersonal sensitivity is a stable trait that reflects ongoing concerns about potential unsatisfactory reactions from others [4].

1.2.4. Affective Characteristics: Withdrawal and Suppressed Emotions.

With increasing age, many inhibited children spend longer periods in solitary activity, whereas non-inhibited children spend longer periods in social behavior [18]. Experimental research showed that behavioral inhibition in early childhood predicted more social withdrawal and less assertive behavior during a social exclusion task in middle childhood [55]. It is particularly the combination of

behavioral inhibition and a cognitive attention bias toward threat that predisposes inhibited children to social withdrawal [5]. Hence, social inhibition is closely related to withdrawal in children [56]. Socially inhibited adults tend to appear quiet on the surface, but they actually may feel tense during social interaction because of their increased awareness of the situation [15]. Research in adults from the general population showed that social inhibition is closely related to social anxiety [57]. Because socially inhibited individuals feel tense during social interaction and tend to expect negative reactions from others, they may avoid social interactions as a self-enhancing strategy [1, 37, 58]. As a result of this tendency to withdraw from others and to inhibit emotional expression [59], socially inhibited adults tend to feel lonely [60] and may lack any close confiding relationships [61, 62].

1.3. Assessment of Social Inhibition in Adulthood

Socially inhibited adults often display prototypical behavioral, cognitive and affective features that also characterize inhibited children, but these different features are often overlooked in adult populations [43]. There exist a number of inhibition self-report measures in adults (Table 1). Examples are the Behavioral Inhibition scale [62], the Adult Measure of Behavioral Inhibition [63], and the inhibition scale of the Emotional Expression Questionnaire [64]. The Heart Patients Psychological Questionnaire includes a short social inhibition scale [65], but this scale has poor internal consistency (Cronbach's $\alpha = .64$). The social inhibition subscale of the DS14 was designed to assess inhibited behavior [66], but generates little or no information on interpersonal sensitivity or social withdrawal. Because there is a need for a brief and valid instrument for the assessment of the different features of adult social inhibition, we developed the 15-item Social Inhibition Questionnaire (SIQ15) which seems to fit these requirements [43]. The inhibition, sensitivity and withdrawal items included in the SIQ15 reflect the proposition that socially inhibited adults are less talkative and inhibited in social interaction, often anticipate negative reactions from others, and may withdraw from situations that they perceive as demanding. These social inhibition features carry over into several areas of

interpersonally functioning in everyday life, causing increased vulnerability to anxiety, depression, and other internalizing problems [61]. However, more research is needed to better understand how and why social inhibition may have adverse effects on mental and physical health in adults [4, 15].

1.4. The Current Research

The present work focused on the multifaceted manifestations of adult social inhibition in the general population and in cardiac patients. Social inhibition is frequently overlooked in adults, and it remains unclear how and when this personality disposition may affect adult health and well-being [15]. Hence, a theoretically-driven approach is essential to identify the potential behavioral, cognitive and affective tendencies that characterize the prototypical responses of socially inhibited adults to perceived social stress in everyday life. Therefore, the aim of Study 1 was to further examine the robustness of our multi-faceted adult social inhibition model, and the aim of Study 2 was to examine the validity of this social inhibition model in a clinical sample of patients with cardiac disease.

2. Study 1: Robustness of the Multi-Faceted Social Inhibition Model

In Study 1, we wanted to evaluate our theoretically based multidimensional measure of social inhibition further. Therefore, we examined the robustness of our multi-facet model of adult social inhibition in two independent samples of (young) adults by using Confirmatory Factor Analysis, and second-order factor analysis of scale scores. This allowed us to investigate whether the different manifestations of adult social inhibition are well represented by the three facet scales of the SIQ15.

2.1. Methods

2.1.1. Participants and procedure

Study 1 included 754 adults from two independent samples. The first sample of young adults comprised of 194 undergraduate psychology students ($M_{age} = 20.6$, $SD = 2.9$, range 18-27; 71%

women) at Tilburg University, who received course credit for participation. The second sample comprised 560 adults ($M_{age} = 47.7$, $SD = 16.0$, range 18-81; 54% women) from the general Dutch population.

Research assistants were responsible for distributing demographic and psychological questionnaires online, and were instructed to collect an equal number of questionnaires from each age and gender sub cohort, without further specification of educational or income level.

Data on demographic variables included age, sex, partner status, and education. Having a partner relationship was defined as being married, living together, or being in a stable relationship, lower education as completing primary school, prevocational education or high school, and higher education as completing vocational education, college, or university. All participants signed an informed consent form and both studies were approved by the institutional ethics review board of Tilburg University (protocol number for young adults sample: EC-2016.26; protocol number for adult sample: EC-2012.23a).

2.1.2. Assessment of Social Inhibition.

All participants completed the Dutch SIQ15 measure of adult social inhibition online at home. Development and initial validation of the SIQ15 is described in greater detail elsewhere [43], and is briefly summarized here. The inhibition facet includes items that measure difficulties in initiating contact [48], and suboptimal conversation skills [35, 48]. High scorers on this facet are less talkative, and may have a hard time making contact with others. The sensitivity facet refers to pervasive social-evaluative concerns [3, 4, 67]. A high score on the sensitivity facet indicates that individuals doubt that they will make a positive impression on others and anticipate negative reactions from others. Items to cover the social withdrawal facet refer to the tendency to withdraw from others [37, 53], and to inhibit emotions in social interactions [66]. Individuals who score high on the withdrawal facet may feel less well connected to others and are not likely to express themselves during social interaction.

Items of the SIQ15 are rated on a 4-point Likert scale ranging from 0 (false) to 3 (true). We calculated a total social inhibition score (sum of all SIQ15 items), as well as scores of the 5-item Inhibition (SIQ15-I), Sensitivity (SIQ15-S), and Withdrawal (SIQ15-W) facet scores of the SIQ15.

2.1.3. Validity of the Social Inhibition Model

Participants completed self-report measures of negative affectivity, anxiety, and depression in order to examine the divergent validity of social inhibition facets as compared to negative emotions. We used the 7-item negative affectivity subscale of the DS14 to assess the tendency to experience negative emotions across time and situations [66]; this measure has a 5-point Likert scale ranging from 0 (false) to 4 (true), with total scores ranging from 0 to 28. The 7-item Generalized Anxiety Disorder scale (GAD-7) was used to assess symptoms of general anxiety [68]. Items on this scale are rated on a 4-point Likert scale from 0 (not at all) to 3 (almost daily), with total scores ranging from 0 to 21. The GAD-7 has good factorial-, construct-, and criterion validity [68]. The 9-item Patient Health Questionnaire (PHQ-9) was used to assess depressive symptoms [69]. This questionnaire scores each of the 9 DSM-IV criteria for depression on a 4-point Likert scale from 0 (not at all) to 3 (nearly every day), with total scores ranging from 0 to 27. Cronbach's α of the DS14 negative affectivity, GAD-7 anxiety, and PHQ-9 depression scales in Study 1 was .89, .89, and .86, respectively.

2.1.4. Statistical analyses

In order to examine the robustness of our multi-faceted model of adult social inhibition, we used Confirmatory Factor Analysis (CFA) to test a model with the Inhibition, Sensitivity and Withdrawal facet measures of the SIQ15 as the latent factors. Five observed variables measure each of the three facets of the SIQ15. The relationship between the factor and its indicator is represented by factor loadings, and the measurement error represents other variation for a particular observed variable.

Measurement equivalence was assessed with multi-group CFA. Structural equation modeling (AMOS, version 23) was used (a) to confirm the factorial structure of the SIQ15, and (b) to examine the individual item loadings on the latent Inhibition, Sensitivity, and Withdrawal facets, and (c) error components and intercepts. We examined 3 nested models: model 1 (unrestrictive model); model 2 (equalizing all factor loadings and error covariances); and model 3 (final model testing the measurement equality of the item intercepts). The χ^2 statistic was not used to examine model fit because its significance is directly related to the sample size, regardless of fit. We used the root mean square error of approximation (RMSEA; $<.08$ = acceptable / < 0.05 = good fit), the normed fit index (NFI; $\geq .90$ = acceptable / $\geq .95$ = good fit), and the comparative fit index (CFI; $\geq .90$ = acceptable / $\geq .95$ = good fit) to estimate the fit of the structural equation models. Pearson's correlations and second-order factor analysis of scale scores were used to examine the divergent validity of our model of adult social inhibition as measured by the SIQ15 facet scales against standard measures of negative affectivity (DS14), anxiety (GAD-7), and depression (PHQ-9).

2.2. Results and conclusions of Study 1

2.2.1. Confirmatory Factor Analysis of the Social Inhibition Model.

The predicted 3-factor measurement model resulting from our theoretical conceptualization, with 15 observed and 3 latent variables, was replicated using CFA in this sample of 754 adults from the Dutch general population (Figure 1). The psychometric plausibility of the factor structure undergirding the SIQ15 was supported by the adequate to good fit of the structural equation model (RMSEA = .052, NFI = .938, and CFI = .957). The standardized regression weights of the 5 items assigned to a factor ranged between .77 and .86 for Inhibition, between .72 and .83 for Sensitivity, and between .59 and .84 for Withdrawal. Error covariance was added to 2 inhibition and 2 withdrawal items with a closely related item content. The regression weights of the Inhibition, Withdrawal and Sensitivity facets (.82, .75 and .68) confirmed the two-level hierarchical model of the SIQ15 as a

multidimensional measure of social inhibition. Cronbach's α and mean inter-item correlations (MIC) supported the internal consistency of the SIQ15 total scale ($\alpha=.95$, MIC=.55), and the Inhibition (SIQ15-I; $\alpha=.93$, MIC=.73), Sensitivity (SIQ15-S; $\alpha=.91$, MIC=.67), and Withdrawal (SIQ15-W; $\alpha=.87$, MIC=.59) facet scales (Table 2).

2.2.2. *Construct validity.*

Intercorrelations of the three facets of the SIQ15 ranged between .61 and .74, confirming that these measures covered related but distinct facets of social inhibition (Table 3). Behavioral inhibition shared around 50% of the variance with interpersonal sensitivity and social withdrawal, while Sensitivity and Withdrawal shared 37% of the variance. Consistent with the findings from Denollet and Duijndam [43], the Sensitivity facet scale had the highest correlations with negative affectivity (.60) and anxiety (.53), while the Inhibition and Withdrawal facets scales correlated between .36 and .43 with negative affectivity, anxiety and depression. Second-order factor analysis of scale scores showed similar results as reported previously by Denollet and Duijndam [43], and confirmed that the Inhibition (.92), Withdrawal (.86), and Sensitivity (.76) facet scales loaded on a broad social inhibition factor, while negative affectivity (.80), anxiety (.90), and depression (.86) loaded on a separate factor (Table 3). Sensitivity had a secondary loading of .44 on this negative emotions factor, which make conceptual sense in that sensitive individuals anticipate negative reactions from others, while those high in negative affectivity are also focused on signs of impending trouble. Overall, these findings confirm the construct validity of the SIQ15 measure of the multi-facet adult social inhibition model.

2.2.3. *Sociodemographic differences.*

Participants' mean score on the SIQ15 was 12.0 ($SD = 9.6$), with mean scores of 3.6 ($SD = 3.6$), 4.3 ($SD = 3.8$) and 4.1 ($SD = 3.4$) on the Inhibition, Sensitivity, and Withdrawal facet scales, respectively (see Table 4, upper panel). Participants with increased social inhibition were significantly younger (M

= 36.9 years, $SD = 17.7$) than those with low inhibition ($M = 44.2$ years, $SD = 17.8$; $F = 31.04$, $p < .001$, $\eta^2 = .040$). Similar age effects were found for the facets scales of the SIQ15. Women scored significantly higher on the total social inhibition score ($M = 12.7$, $SD = 9.88$) as compared to men ($M = 11.1$, $SD = 9.0$; $F = 5.20$, $p = .023$, $\eta^2 = .007$), with the Sensitivity facet contributing the most to this sex difference (women: $M = 5.0$, $SD = 3.9$; men: $M = 3.4$, $SD = 3.3$; $F = 32.51$, $p < .001$, $\eta^2 = .042$). No sex differences were found for the Inhibition and Withdrawal facets of the SIQ15 (Table 4, upper panel). In addition, participants without a partner scored higher on the total score of the SIQ15 ($M = 14.3$, $SD = 9.7$) as compared to participants with a partner ($M = 10.9$, $SD = 9.3$; $F = 20.39$, $p < .001$, $\eta^2 = .026$). This partner effect was also found for each of the three facet scales. Educational level was not significantly associated with any of the scores of the SIQ15.

2.2.4. Conclusions of Study 1

In sum, the findings of the CFA and second-order factor analysis confirmed that the different manifestations of adult social inhibition are represented well by the three facet scales of the SIQ15, and that the total score of the SIQ15 clearly reflects the broad social inhibition domain. In addition, item-total correlations supported the internal consistency of the total scale of the SIQ15, but also of the Inhibition, Sensitivity, and Withdrawal facets. Also, we found inhibition, sensitivity, and withdrawal to be closely related but not identical constructs, representing different manifestations of social inhibition. Sensitivity was more related to items of distress, which is in accordance with previous findings [43] and makes conceptual sense. High social inhibition scores were associated with younger age, female sex (with Sensitivity contributing the most), and being without a partner. Altogether, these findings supported the robustness of our multi-facet social inhibition model, and indicated that the SIQ15 is a valid self-report measure of this model in adults.

3. Study 2: Inhibition, Sensitivity And Withdrawal in Cardiac Patients

In Study 2, we wanted to further examine our conceptual model in a sample of cardiac patients. It is important to identify theoretically sound ways to assess social inhibition in other samples than the general population, to further increase our understanding of individual differences in social stress that affect health. Previous research has shown that social inhibition is associated with the incidence and prognosis of cardiovascular disease (e.g., [70, 71]). However, which facets of the social inhibition domain are related to cardiovascular health outcomes is still unknown [14], and insight in this may help to clarify the complexity of how social inhibition may influence health [72]. Moreover, the combination of social inhibition with negative affectivity has been associated with an increased prevalence of mental disorders such as social phobia, dysthymia, and avoidant personality disorder among cardiac patients [73]. We therefore wanted to examine the validity of our multifaceted social inhibition model in a clinical sample of patients with cardiac disease in Study 2.

3.1. Methods

3.1.1. Participants and procedure.

The participants of Study 2 comprised 145 patients from the outpatient cardiac rehabilitation program of the Antwerp University Hospital in Belgium. The mean age of this sample was 59.3 years ($SD = 12.0$; range 16-82), 26% were women, and 81 patients (56%) were diagnosed with coronary artery disease and 64 (44%) with heart failure or cardiomyopathy. All patients entering the cardiac rehabilitation program were included, provided that they had sufficient understanding of the Dutch language. Patients with a cognitive or psychiatric disorder were excluded. At the start of the rehabilitation program, patients were approached by a social nurse who explained the study content and its requirements. After giving written consent, all participants completed the Dutch SIQ15 measure of adult social inhibition at home. In the last week of the rehabilitation program (at three months follow up), included patients were again asked to complete the SIQ15 measure at home. The

study protocol is in keeping with the Helsinki declaration and was approved by the institutional medical ethics review board (Protocol number EC UZA16/50/545).

3.1.2. Social Inhibition.

All patients ($N = 145$) completed the SIQ15 measure of adult social inhibition at baseline, when entering the outpatient cardiac rehabilitation program. A subset of 81 patients also completed the SIQ15 at three months follow up, at the end of the rehabilitation program. Items of the SIQ15 are rated on a 4-point Likert scale ranging from 0 (false) to 3 (true). A total social inhibition score (sum of all SIQ15 items) was calculated, as well as scores of the 5-item Inhibition (SIQ15-I), Sensitivity (SIQ15-S), and Withdrawal (SIQ15-W) facet scores. Cronbach's α of the total score in Study 2 was .95.

3.1.3. Negative affectivity, Anxiety and Depression.

In accordance with the approach taken in Study 1, we validated our social inhibition model against the DS14-NA [66], GAD-7 [68], and PHQ-9 [69] measures of negative affectivity, general anxiety, and depressive symptoms in the current population of cardiac patients. Cronbach's α of these scales was .89, .90, and .88, respectively.

3.1.4. Related measures of Inhibition and Withdrawal.

We also validated our multifaceted social inhibition model and its assessment with the SIQ15 against theoretically related inhibition measures. The 4-item Behavioral Inhibition Scale (BIS4; [62]) was used to assess behavioral inhibition in response to novel situations. We expect the SIQ15-I facet scale to correlate highly with the BIS4. We used the 10-item Withdrawal scale from the Detachment domain of the Personality Inventory for DSM-5 (PID-5; [74]) to assess withdrawal from social situations. The SIQ15-W facet scale is expected to be mostly related to the PID-5 Withdrawal scale. Cronbach's α of the BIS4 and PID-5 Withdrawal scales were .76 and .94.

3.1.5. Statistical Analyses.

First, corrected item-total correlations and Cronbach's α were used to examine the internal consistency of the Inhibition, Sensitivity and Withdrawal facet scales of the SIQ15. Second, Pearson's r were used to examine (a) the convergent validity of the SIQ15 measures of inhibition, sensitivity and withdrawal against the BIS4 and PID-5 measures of behavioral inhibition and social withdrawal, and (b) the divergent validity of the SIQ15 against measures of negative affectivity (DS14 subscale NA), anxiety (GAD-7), and depression (PHQ-9). Third, second-order factor analysis of scale scores was used to examine the construct validity of our social inhibition model against measures of negative emotions, behavioral inhibition, and withdrawal in cardiac patients. Finally, Pearson's correlations were used to estimate the test-retest stability of the total SIQ15 social inhibition score and each of the three inhibition facet scores over a three month period of time.

3.2. Results and conclusions

3.2.1. Internal validity and reliability.

Cronbach's α (SIQ15-I, $\alpha = .94$; SIQ15-S, $\alpha = .90$; SIQ15-W, $\alpha = .86$) and corrected item-total correlations ranging between .55 and .90 indicated a high level of internal consistency in the cardiac population (Table 5). The total SIQ15 scale showed a Cronbach's α of .95. At three months follow up, these high internal consistency levels were confirmed (SIQ15-I, $\alpha = .94$; SIQ15-S, $\alpha = .91$; SIQ15-W, $\alpha = .83$; total SIQ15 scale, $\alpha = .95$). Lastly, test-retest correlations between baseline and three month follow up assessments were high for all SIQ15 scales (Inhibition, $r = .80$; Sensitivity, $r = .82$; Withdrawal, $r = .78$; total Social Inhibition, $r = .83$), indicating a good long-term stability of the SIQ15 and its three facet measures of social inhibition.

3.2.2. Construct validity.

The intercorrelations of the three facet scales of the SIQ15 ranged between .61 and .81 (Table 6). As predicted, Inhibition (SIQ15-I) was highly correlated with behavioral inhibition ($r = .71$), but also with withdrawal ($r = .71$). In addition, Withdrawal (SIQ15-W) was highly correlated with withdrawal as measured by the PID-5 ($r = .77$), and with behavioral inhibition ($r = .59$). Sensitivity correlated with both measures of inhibition (behavioral inhibition, $r = .51$; withdrawal, $r = .51$). Also, Sensitivity and Withdrawal was related to negative affectivity (.51 and .42), and Sensitivity to depression (.40), which reflects the tendency of people high in interpersonal sensitivity to anticipate negative reactions. Second-order factor analysis further confirmed the construct validity of our model. Inhibition (.91), Sensitivity (.71), Withdrawal (.90), behavioral inhibition (.77) and withdrawal as measured by the PID-5 (.77), all loaded on one social inhibition factor, while negative affectivity (.92), anxiety (.90) and depression (.75) loaded on a separate emotional distress factor (Table 6).

3.2.3. Sociodemographic differences.

The average score on the total SIQ15 was 11.3 ($SD = 9.7$), with average scores of 3.5 ($SD = 3.8$), 3.5 ($SD = 3.4$), and 4.4 ($SD = 3.6$) on the inhibition, sensitivity, and withdrawal facets (see Table 4, lower panel). No sex differences were found for the total SIQ15 score or Sensitivity, however men scored significantly higher on Inhibition ($M = 3.9$, $SD = 4.0$) compared to women ($M = 2.2$, $SD = 2.8$; $F(1, 144) = 5.97$, $p = .016$, $\eta^2 = .040$), and men also had a higher Withdrawal score ($M = 4.8$, $SD = 3.7$) than women ($M = 3.2$, $SD = 3.1$; $F(1, 144) = 5.90$, $p = .016$, $\eta^2 = .040$). No differences were found between participants with or without a partner. In addition, no age differences were found for high and low social inhibition.

3.2.4. Conclusions Study 2

To summarize, the findings of Study 2 further supported the multi-facet model of adult social inhibition [43] in a sample of cardiac disease patients. Correlational and factor analytic data confirmed

the validity of the SIQ15, which reflects three distinct but related facets of adult social inhibition. Sum scores of the three SIQ15 scales were internally consistent and loaded on the same underlying social inhibition dimension, together with behavioral inhibition and withdrawal as measured by the PID-5. In accordance with previous research [43], the facets' sum scores were limited in overlap with standard measures of emotional distress, indicating good divergent validity. In addition, Study 2 showed strong test-retest correlations ($\geq .78$), indicating that this measurement of social inhibition is stable over a 3-months period of time in a cardiac patient population. We also found sex differences between the facets of social inhibition, with men reporting higher inhibition and withdrawal scores, compared to women. In addition to the validity of the SIQ15 in a general population, the findings of Study 2 support the SIQ15 as a measure of adult social inhibition in a clinical sample.

4. General Discussion

The findings of the present research indicated the robustness of the theoretical model that we proposed, to study adult social inhibition as a multi-facet disposition [43]. In Study 1, confirmatory factor analysis showed that behavioral inhibition, interpersonal sensitivity and social withdrawal emerged as three distinct facets stemming from the broad personality domain of adult social inhibition, as predicted by theory. In Study 2, empirical research in cardiac patients further supported the construct validity of this model in the clinical setting, and suggested that men with cardiac disease may display more behavioral inhibition and withdrawal compared to women.

4.1. Robustness of Inhibition, Sensitivity and Withdrawal Facets in Adults

Second-order factor analysis in both a general population and a cardiac patient sample, indicated that the inter-correlation between facet scores was explained by a single higher-order factor representing a general social inhibition domain. In accordance with our previous research [43], the SIQ15 and its three facet scales again proved to be internally consistent and stable trait measures, with

Cronbach's $\alpha \geq .83$ and test-retest correlations $\geq .78$. Hence, the SIQ15 assesses individual differences in adult social inhibition both at the level of a broad trait and at the level of specific behavioral, cognitive and affective tendencies. These results are in keeping with the theoretical model of adult social inhibition as a multi-facet construct, and further support the SIQ15 as a brief, valid self-report measure in both healthy and clinical samples.

4.2. Social Inhibition and Cardiovascular Disease

Previous research in cardiac patients showed that the combination of social inhibition with negative affectivity is associated with an increased prevalence of dysthymia, social phobia, and other mental disorders [73]. However, in addition to mental health problems, behaviorally inhibited individuals have also been found to be more susceptible to the adverse effects of social stress on physical health [33, 34, 75]. For example, elevated cortisol levels have been reported in inhibited children [76, 77] and adults [14, 78], which may be a factor contributing to increased prevalence of stress-related illnesses.

Adverse cardiovascular stress responses involving heart rate, ventricular contractility, cardiac output, and total peripheral resistance, are associated with the experience of repeated social threat [7-10]. Accordingly, recurrent social stress is found to be a risk factor for cardiovascular disease and premature mortality [7, 11-13]. Given the difficulties of socially inhibited individuals to deal with everyday social stress and to form stable social relationships, these individuals in particular may have increased risk of adverse cardiovascular outcomes due to recurrent social stress. Social inhibition has been related to changes in cardiac output and total peripheral resistance [79], which may explain why individual differences in perceived social threat are related to increased vascular resistance [80, 81]. Clinical research also indicates that social inhibition interacts with negative affect to predict an increased risk of adverse cardiovascular events and death following percutaneous coronary intervention [70] and cardiac rehabilitation [71] in patients with coronary artery disease. Overall, these

findings indicate that we need to improve our knowledge about the biological and psychological correlates of social inhibition in relation to physical and mental health outcomes .

4.3. Biological and Psychological Correlates of Social Inhibition

Social inhibition has a biological underpinning in temperament, which refers to a genetically influenced pattern of behaviors, cognitions, and emotions first observed in infants and young children [19, 44, 46]. In children, inhibited temperament has been found to be associated with heightened arousal and stress responses (e.g., [82, 83]) and elevated baseline and stress-related cortisol [76, 77]. In adults, some studies have found that social inhibition was associated with elevated blood pressure and heart rate reactivity, and greater cortisol reactivity to stress [14, 78]. These alterations in the sympathetic response and cortisol release, may indicate a neural basis in inhibited temperament. Indeed, alterations in a complex neuro circuit including the amygdala, hippocampus, basal ganglia, and prefrontal regions, responsible for novelty detection, attention, and sensitivity to the environment, have been related to social inhibition [6, 84, 85].

Individual differences in social inhibition are also closely related to interpersonal problems. Socially inhibited individuals often feel cut off from others [61], and are characterized by an approach-avoidance conflict; i.e., they are motivated to approach another person, but this approach tendency is inhibited due to concerns about possible negative reactions from others [25]. Hence, social inhibition needs to be distinguished from introversion or low sociability [25, 72]. Many introverted individuals are not reticent during social contacts because they feel tense when with others, as is the case with inhibited individuals, but rather because they prefer their own company to that of others [72]. Low sociability also refers to this preference for being alone, but not to the vulnerability to social stress of inhibited individuals. Socially inhibited adults may be highly critical of others much like they are to themselves [54], and are often characterized by anger rumination and higher levels of suppressed hostility [86, 87].

Across the lifespan, behavioral inhibition becomes a vulnerability factor for the development of mental health problems [20, 88], anxiety disorder [34, 89] and social anxiety disorder [90, 91], especially in women [92]. In adult populations, social inhibition has been associated with an increased risk of internalizing problems and higher symptom levels of anxiety, depression and posttraumatic stress [60, 61, 93]. In patients with major depression, social inhibition was related to an increased risk of suicide attempt [94]. Of note, the combination of social inhibition with negative affectivity, which defines Type D personality [66], has also been related to increased vulnerability for suicidal ideation in the general population [95, 96] and in patients with cardiac disease [75].

4.4. Sex, Age, and Partner Status Differences In Social Inhibition

In Study 2, we found that men with cardiac disease scored significantly higher on both behavioral inhibition and social withdrawal as compared to women with cardiac disease. We did not find this sex difference in the general population, which may indicate that behavioral inhibition and social withdrawal may be particularly relevant among men with cardiac disease. At present, we can only speculate about potential explanations for these findings. For example, this might indicate that men who are diagnosed with cardiac disease might be more susceptible to adverse cardiovascular reactions in response to the elevated levels of perceived social stress associated with inhibition and withdrawal. In addition, men tend to suppress their emotions more than women do [97], and suppressed anger has been related to an increased risk of adverse events in cardiac patients [98]. Given the usefulness and validity of the SIQ15 in cardiac patients, future research using this instrument could improve our understanding of the role of social inhibition and its different manifestations in the context of cardiovascular disease, particularly among men.

Consistent with previous findings in an independent sample [43], we also observed sex, age and partner status differences in social inhibition in respondents from the general population. Women reported higher interpersonal sensitivity compared to men, which is in agreement with previous

research [43], but this sex difference was not found in the cardiac population. Because higher social inhibition is associated with younger age [43], and our cardiac sample was older compared to the general population ($M_{\text{difference}}=18.7, p < .001$), we speculate that social inhibition might decline with age. According to these findings, more research is needed to examine individual differences in demographic characteristics associated with social inhibition in adults.

4.5. Limitations and Strengths

The results of this study need to be viewed with its limitations and strengths in mind. The sample of Study 2 predominantly consisted of men (75%), which is to be expected from a cardiac patient sample with a mean age of 59 years. Second, our findings are based on self-report, and in order to examine the explanatory and predictive value of our adult social inhibition model, experimental and longitudinal studies are necessary to investigate experimental stress reactivity and health outcomes. Strengths of the current study are the conceptual framework of our model, the relatively large number of respondents, and the inclusion of two independent samples of which one was a clinical sample, that allowed for replication of findings. Further, the use of different statistical approaches to examine the validity and reliability of the SIQ15 is another strength.

4.6. Conclusion

The findings of our current research clearly indicated the feasibility of parsing the broader social inhibition construct into finer grained facets that distinguish between the behavioral, cognitive and affective facets of this broad disposition. In Study 1, confirmatory factor analysis supported the robustness of our multi-facet social inhibition model based on three correlated factors, and Study 2 indicated the validity of our theory-based model in a clinical sample of patients with cardiac disease. The SIQ15 proved to be a brief and valid self-report measure that allows for the reliable assessment of our social inhibition model in an adult general population sample and cardiac patient sample, both

at the broad, general trait level and at the level of more specific behavioral, cognitive, and affective tendencies. Inclusion of the SIQ15 in future research may improve our understanding of how different manifestations of social inhibition in adults are related to stress reactivity and, eventually, to mental and physical health outcomes.

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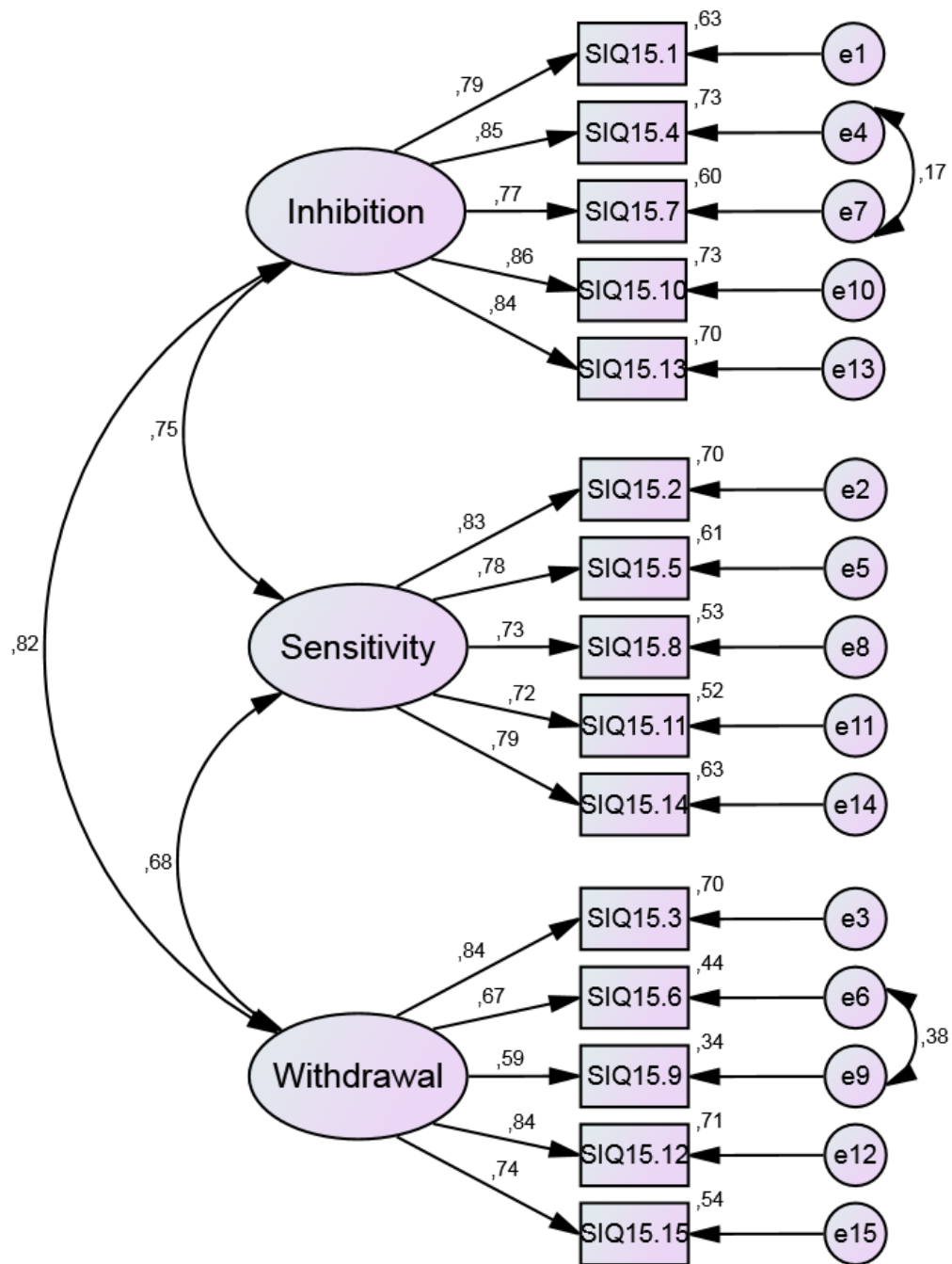


Figure 1. Confirmatory Factor Analysis of the SIQ15 in Adults ($n=754$)

Table 1 *Examples of Self-Report Measures of Inhibition in Adolescence and Adulthood*

Author	Measure	Age	# of items	Content	Reliability	Validation
Reznick et al. [88]	<i>Retrospective Self-Report of Inhibition</i>	Adults and adolescents	30 items	Recollection of social and school related fears, general fears	Cronbach's $\alpha=.79$	$r=.56$ with behavioral inhibition in adulthood
Gladstone & Parker [63]	<i>Adult Measure of Behavioral Inhibition (AMBI)</i>	Adults, 18 y and older	16 items	Fearful inhibition, low sociability, risk avoidance	Cronbach's $\alpha=.87$ Test-retest $r=.86$	$r=.75$ with introversion $r=.77$ with social anxiety $r=.74$ with avoidant personality
Carver & White [99]	<i>Behavioral Inhibition scale of the BIS/BAS</i>	Adults	7 items	Sensitivity to negative, potentially threatening social situations	Cronbach's $\alpha=.74$	$r=.59$ with harm avoidance $r=.58$ with manifest anxiety $r=.45$ with negative affectivity
Gest [62]	<i>Behavioral Inhibition Scale BIS4</i>	Children and adolescents	4 items	Behavioral inhibition in response to novel social situations	Cronbach's $\alpha=.94$	Non-significant correlations with peer acceptance
Roger & Najarian [64]	<i>Emotional Inhibition scale of the ECQ</i>	Adults	10 items	Inhibition of emotional expression in social situations	Kuder-Richardson $=.77$	$r=.37$ with introversion $r= -.56$ with interpersonal control
Cole et al. [100]	<i>Composite measure of social inhibition</i>	Adults	Items from 7 scales	Avoidance, emotional inhibition, introversion hostility/irritability	Cronbach's $\alpha=.81$	$r=.63$ with hostility/irritability $r=.22$ with manifest anxiety
Denollet [66]	<i>Social inhibition scale of the DS14</i>	Adults and adolescents	7 items	Inhibition in social interactions, reticence, lack of social poise	Cronbach's $\alpha=.86$ Test-retest $r=.82$	$r= -.65$ with extraversion
Denollet & Duijndam [43]	<i>SIQ15 15-item Social Inhibition Scale</i>	Adults and adolescents	15 items	Behavioral inhibition, Interpersonal sensitivity, Social withdrawal	Cronbach's $\alpha=.86-.94$ Test-retest $r=.73-.78$	$r=.72$ with inhibition (BIS4) $r=.42$ with rumination (PSWQ) $r=.72$ with withdrawal (PID-5)

Note. BIS/BAS= Behavioral Inhibition Scale/Behavioral Activation Scale; BIS4= 4-item Behavioral Inhibition Scale; ECQ=Emotion Control Questionnaire; PSWQ=Penn State Worry Questionnaire; PID-5= Personality Inventory for DSM-5.

Table 2

Internal Consistency of the SIQ15 Measures of Behavioral Inhibition, Interpersonal Sensitivity, and Social Withdrawal in Adults from the General Population (N=754)

Items of the SIQ15	Internal Consistency ^a
Inhibition facet scale (SIQ15-I)	
(1) I often feel inhibited in social interactions	.76
(4) I find it hard to start a conversation	.87
(7) When socializing, I don't find the right things to talk about	.80
(10) When I meet people, I have difficulty making contact	.85
(13) I have difficulty talking with other people	.83
	$\alpha = .93$
Sensitivity facet scale (SIQ15-S)	
(2) I often worry that others may disapprove of me	.81
(5) I feel insecure when I don't know another person's thoughts on me	.79
(8) I always expect negative reactions from others	.75
(11) I avoid saying what I think for fear of being rejected	.71
(14) I often think that others may find fault with me	.81
	$\alpha = .91$
Withdrawal facet scale (SIQ15-W)	
(3) I avoid getting close to other people	.72
(6) I am a closed kind of person	.71
(9) Most of the time, I hide my feelings	.65
(12) I would rather keep other people at a distance	.78
(15) I avoid personal ties with other people	.67
	$\alpha = .87$

Note. ^aCorrected item-total correlations

SIQ15 = 15-item Social Inhibition Questionnaire

Table 3*Construct Validity of the Social Inhibition Model in Adults from the General Population (N=754)*

Items/Scales	Correlations ^a			Second-Order Factor Analysis ^b	
	SIQ15-I	SIQ15-S	SIQ15-W	I	II
Inhibition (SIQ15-I)	-	-	-	.92	.17
Sensitivity (SIQ15-S)	.72	-	-	.76	.44
Withdrawal (SIQ15-W)	.74	.61	-	.86	.22
Negative Affectivity (DS14)	.40	.60	.43	.31	.80
Anxiety (GAD-7)	.36	.53	.38	.20	.90
Depression (PHQ-9)	.38	.48	.41	.23	.86

Note. ^aCorrelations $\geq .40$ and factor loadings $\geq .50$ are presented in boldface. ^bFactor analysis of sum scores of the SIQ15 Inhibition, Sensitivity and Withdrawal facet scales, and the Negative Affectivity, Anxiety and Depression scales.

SIQ15 = 15-item Social Inhibition Questionnaire 15; SIQ15-I = Inhibition facet scale; SIQ15-S = Sensitivity facet scale; SIQ15-W = Withdrawal facet scale; DS14 = Type D Personality Scale; GAD-7 = Generalized Anxiety Disorder Scale; PHQ-9 = Psychological Health Questionnaire.

Table 4

Overall mean (SD) scores of the SIQ15 total and facet scores in men and women for both the general population and cardiac patient samples.

<i>General population</i>				
Items	Total (N=751)	Men (n=311)	Women (n=440)	<i>F</i>
SIQ15 Total	12.00 (9.56)	11.06 (9.02)	12.67 (9.88)	5.20*
Inhibition (SIQ15-I)	3.55 (3.58)	3.32 (3.49)	3.72 (3.64)	2.24
Sensitivity (SIQ15-S)	4.35 (3.76)	3.43 (3.33)	4.99 (3.92)	32.51**
Withdrawal (SIQ15-W)	4.10 (3.40)	4.30 (3.39)	3.96 (3.39)	1.86
<i>Cardiac patients</i>				
Items	Total (N=145)	Men (n=108)	Women (n=37)	<i>F</i>
SIQ15 Total	11.32 (9.69)	12.19 (9.95)	8.76 (8.50)	3.53
Inhibition (SIQ15-I)	3.46 (3.80)	3.90 (4.00)	2.16 (2.77)	5.97*
Sensitivity (SIQ15-S)	3.48 (3.41)	3.50 (3.38)	3.43 (3.52)	.01
Withdrawal (SIQ15-W)	4.38 (3.59)	4.80 (3.66)	3.16 (3.13)	5.90*

Note. *p-value $\leq .05$, ** p-value $\leq .001$.

SIQ15 = 15-item Social Inhibition Questionnaire 15; SIQ15-I = Inhibition facet scale; SIQ15-S = Sensitivity facet scale; SIQ15-W = Withdrawal facet scale

Table 5

Internal Validity of the SIQ15 Measures of Behavioral Inhibition, Interpersonal Sensitivity, and Social Withdrawal in Cardiac Patients (N = 145)

Items of the SIQ15	Internal Consistency ^a
Inhibition facet scale (SIQ15-I)	
(1) Feels inhibited in social interactions	.77
(4) Finds it hard to start a conversation	.90
(7) Does not find the right things to talk about	.80
(10) Has difficulty making contact	.86
(13) Has difficulty talking with other people	.90
	$\alpha = .94$
Sensitivity facet scale (SIQ15-S)	
(2) Worries that others may disapprove of him/her	.80
(5) Insecure when not knowing another's thoughts	.73
(8) Expects negative reactions from others	.81
(11) Inhibits self-expression for fear of being rejected	.68
(14) Thinks that others may find fault with him/her	.79
	$\alpha = .90$
Withdrawal facet scale (SIQ15-W)	
(3) Avoids getting close to other people	.71
(6) Is a closed kind of person	.69
(9) Hides his/her feelings	.55
(12) Keeps other people at a distance	.80
(15) Avoids personal ties with other people	.69
	$\alpha = .86$

Note. ^aCorrected item-total correlations.

Table 6*Construct Validity of the Social Inhibition Model in Cardiac Patients (N=145)*

Items/Scales	Correlations ^a			Second-Order Factor Analysis ^b	
	SIQ15-I	SIQ15-S	SIQ15-W	I	II
Inhibition (SIQ15-I)	-	-	-	.92	.17
Sensitivity (SIQ15-S)	.72	-	-	.76	.44
Withdrawal (SIQ15-W)	.74	.61	-	.86	.22
Behavioral Inhibition (BIS4)	.71	.51	.59	.77	.07
Withdrawal (PID-5)	.64	.51	.77	.77	.19
Negative Affectivity (DS14)	.40	.60	.43	.31	.80
Anxiety (GAD-7)	.36	.53	.38	.20	.90
Depression (PHQ-9)	.38	.48	.41	.23	.86

Note. ^aFactor analysis of of sum scores of the different scales.

Correlations $\geq .40$ and factor loadings $\geq .50$ are presented in boldface.

SIQ15 = 15-item Social Inhibition Questionnaire 15; SIQ15-I = Inhibition facet scale; SIQ15-S = Sensitivity facet scale; SIQ15-W = Withdrawal facet scale; BIS4 = 4-item Behavioral Inhibition Scale; PID-5 = Personality Inventory for DSM-5; DS14 = Type D Personality Scale; GAD-7 = Generalized Anxiety Disorder Scale; PHQ-9 = Psychological Health Questionnaire.